DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a plasma display (it is called Following PDP).
[0002]
[Description of the Prior Art] Compared with a liquid crystal display, a high-speed display is possible for PDP, and since enlargement is easy, it is expected in fields, such as OA equipment and an information display. Moreover, possibility that there will be progress in the field of a TV with Internet functions or high-definition television, and the commercial scene of PDP will spread is found out.
[0003] full color in connection with expansion of a commercial scene -- PDP attracts attention. The structure of PDP currently developed by the current general ones is a field discharge AC method, and it encloses rare gas between a front plate and two substrates of a tooth-back plate, and it is made it to carry out plasma discharge by inter-electrode [of a front plate]. At this time, the enclosed gas is excited and generates 147nm ultraviolet rays, and these ultraviolet rays excite the fluorescent substance of red, green, and blue, and emit light in the light. Thus, the full color display is enabled.
[0004] The tooth-back plate for PDP consists of the electrode formed on the glass substrate, a dielectric layer, a septum, and a fluorescent substance layer. Among these, the fluorescent substance layer is formed on the electrode in the space divided with the side face of a septum and septum which were formed in the shape of a stripe, and the septum. A fluorescent substance layer needs to carry out pattern formation of the three color [one] of red, green, and blue to each three, respectively, and is usually formed using pattern print processes or the photolithography method. In pattern print processes, a fluorescent substance paste is screen-stenciled using a pattern mark lithographic plate, and a fluorescent substance pattern is formed. On the other hand, after applying a photosensitive fluorescent substance paste to the glass substrate whole surface in which the electrode, the dielectric layer, and the septum were formed in the photolithography method at homogeneity, exposure and development are performed and the pattern of a fluorescent substance is formed. After pattern formation, in any case, it calcinates and it obtains a fluorescent substance layer. Thus, at the time of baking, the binder component under paste decomposes, the fluorescent substance layer formed is burned down, and only inorganic fluorescent substance powder remains. therefore -- high -- in order to obtain a brightness display, it is necessary to make the filling factor of fluorescent substance powder high for example, particle size -- as 2-5 micrometers -- particle size distribution -- a filling factor -- changing -- high -- in order to obtain brightness PDP, the particle size distribution of the fluorescent substance powder under paste used for pattern print processes or the photolithography method become important. Although the fluorescent substance layer for high brightness achievement (for example, the approach of mixing two kinds of powder with which particle size is different like JP,7-24506,A) was made into two-layer structure and the tooth-back plate with a lower layer more precise than the upper layer was proposed, it was not enough in respect of luminous efficiency or brightness.
[0005]
[Problem(s) to be Solved by the Invention] Then, the purpose of this invention is to offer the high brightness luminescence PDP.
[0006]
[Means for Solving the Problem] The purpose of this this invention is attained by PDP characterized by including the fluorescent substance layer which loosens with tap density and consists of the fluorescent substance powder whose ratios of an umbrella consistency are 0.3-0.6.
[0007]
[Embodiment of the Invention] The fluorescent substance layer of the tooth-back plate which constitutes PDP can be formed by removing an organic component by baking, after applying the fluorescent substance paste which uses fluorescent substance powder and an organic component as a principal component in the discharge space between septa, and a full color display is attained by forming in the appointed discharge space, respectively using the fluorescent substance paste containing red (R), green (G), and the powder that emits light in each blue (B) color.
[0008] By loosening with the tap density of the fluorescent substance powder used for formation of a fluorescent substance layer, and setting the ratio (tap density / looseness umbrella consistency) of an umbrella consistency to 0.3-0.6, especially this invention is precise, and there are few defects, it serves as a fluorescent substance layer with high luminescence brightness, and offers PDP of high display quality. The fluorescent substance layer formed as this ratio is less than 0.3 serves as roughness and fineness, and peeling from a crack or a substrate produces it at the time of baking and other processes. Moreover, if 0.6 is exceeded, the filling factor of fluorescent substance powder will become high

too much, and a flat surface without irregularity is made. For this reason, there is less luminescence surface area than an irregular field, and brightness becomes low and does not attain the purpose of invention.

[0009] It loosens here and an umbrella consistency is the mass of the powder per [which measured and obtained powder mass when having put in and printed powder in 100 cc container] unit volume. Moreover, tap density is the powder mass per [which had printed powder, and measured and obtained powder mass] unit volume, after vibrating 100 cc container into which powder was put for 5 minutes (tapping). In this invention, it loosened and the Seishin Enterprise fine-particles property measuring instrument of multi-circuit tester MT-1000 was used for measurement of an umbrella consistency and tap density.

[0010] In order to form PDP of high brightness luminescence furthermore, as a result of examining wholeheartedly the particle size and particle size distribution of fluorescent substance powder, about the accumulation mean particle diameter of fluorescent substance powder, it was desirable that it was 0.5-7.0 micrometers, and it became clear that it is 1.0-3.5 micrometers more preferably. It is it easy to condense fluorescent substance powder that accumulation mean particle diameter is less than 0.5 micrometers, and an opening becomes easy to be made, when homogeneity does not distribute but the spreading film is formed during a paste. Moreover, if 7.0 micrometers is exceeded, it will be hard to form the film of a uniform fluorescent substance layer. Moreover, as for specific surface area, it is desirable that it is 0.1-5.0m2/cc. if powdered surface area becomes it small that it is less than [0.1m2/cc], the luminous efficiency of a fluorescent substance falls, 5.0m2/cc is exceeded and it will come to be alike, the fluorescent substance layer of PDP will become thick too much, and it will fully be hard coming to secure discharge space Furthermore, as for the standard deviation of the particle size of fluorescent substance powder, it is desirable that it is 0.5-5.0 in respect of the rate of packing. The standard deviation said here is the value of /2 defined from d84% obtained at the time of particle-size-distribution measurement, and d16% (particle size in case volume particle size becomes 16% and 84% by accumulation is made into d16% and d84%, respectively) (d84%-d16%). If standard deviation becomes less than 0.5, a filling factor will worsen [particle diameter] [too much], and an opening will increase between powder. Moreover, if 5.0 is exceeded, variation will appear in powdered magnitude and it will be hard coming to obtain the fluorescent substance layer of uniform thickness. In addition, measurement of the standard deviation of accumulation mean particle diameter, specific surface area, and particle size shall be performed using HRA9320-X100 made from Microtrac.

[0011] As red, the fluorescent substance powder used by this invention Moreover, BO(Y, Gd)3:Eu, as Y2O3:Eu, Y(P, V) O3:Eu, and blue -- BaMgAlxOy:Eu (x --) y -- the natural number of 1-50 -- especially -- desirable -- as green, they are [BaMgAl10O17:Eu and] Zn2SiO4:Mn, BaAl12O19:Mn, etc. -- high -- it is desirable at the point of obtaining brightness PDP.

[0012] As PDP of this invention, the following are mentioned as an example, for example. That is, on the glass substrate, it has the electrode pattern of the shape of two or more stripe, the dielectric layer is formed on it at the whole surface, and two or more formation of the septum whose height is 60-150 micrometers further is carried out inter-electrode. The fluorescent substance layer is formed in the pars basilaris ossis occipitalis in the discharge space divided with the side face of a septum, and the septum.

[0013] Although not limited, especially the approach of forming an electrode at this time is an approach of the pattern of a photo mask being burned by exposure, forming an electrode pattern by development, calcinating after that, and obtaining an electrode, as one example of the desirable manufacture approach, after printing photosensitive conductive paste completely on a glass substrate.

[0014] Thus, an electrode with a thickness of 1-10 micrometers is formed. Then, a dielectric layer with a thickness of 10-25 micrometers is formed on an electrode with screen printing. Although especially a paste is not limited, it is desirable to use the dielectric paste which uses glass powder and an organic component as a principal component. Since it heats at 70-90 degrees C for 20 to 60 minutes, the dielectric layer printed by the whole surface is dried and solvents are evaporated, a dielectric layer is calcinated in air. A binder component, a solvent, etc. which are an organic component oxidize, and make it evaporate completely at this process. It is desirable that it calcinates at 560-610 degrees C as temperature conditions for 15 minutes to 1 hour, and can be burned on a glass substrate.

[0015] Thus, on the made dielectric layer, pattern formation of the septum with a height [of 50-200 micrometers] and a width of face of 10-80 micrometers is carried out to the shape of a stripe. As the formation approach of a septum, well-known approaches, such as the sandblasting method, pattern print processes, an embedding method, a replica method, and a metal mold method, can be used. There is the photolithography method using photosensitive mull technique as a desirable example. After a photosensitive septum paste's using glass powder and an organic component as a principal component and printing this paste several times with screen printing on a dielectric layer, a septum pattern is formed by drying, exposing and developing negatives. The target septum configuration is formed by calcinating this.

[0016] In order to carry out pattern formation of the photosensitive septum paste on the low glass substrate of a glass transition point and softening temperature in this invention, as for glass powder, it is desirable that it is what glass transition temperature becomes from the glass ingredient 430-500 degrees C and whose softening temperature are 470-580 degrees C. Moreover, it is desirable that high-melting glass powder is included, and that a maximum grain size is 6-12 micrometers in 1.5-2.5 micrometers has the desirable mean particle diameter of this high-melting glass powder at the point which lessens coherent.

[0017] Next, a fluorescent substance layer is formed between the septa obtained by the above-mentioned approach. The presentation of the fluorescent substance paste used at this time changes with approaches to carry out pattern processing of RGB each color. Well-known approaches, such as screen printing, photosensitive mull technique, the ink jet method, and the dispenser method, can be used for the pattern processing approach. The example of photosensitive mull technique is explained as the desirable pattern processing approach.

[0018] What uses the above-mentioned fluorescent substance powder and a photosensitive organic component as a principal component as a photosensitive fluorescent substance paste used for photosensitive mull technique is mentioned. The rate V of a volume ratio of the fluorescent substance powder under paste has the desirable range of 13 - 20vol%. A crack goes into a fluorescent substance layer by the contraction at the time of a binder decomposing that the rate of a volume ratio is less than [13vol%] at the time of baking, and being burned down, or the problem of omission of a fluorescent substance layer arises from a substrate. Moreover, if 20vol% is exceeded, viscosity will become high and it will become very difficult to carry out printing and spreading. Moreover, since the contraction at the time of baking becomes small, the thickness of a fluorescent substance layer becomes thick.

[0019] Moreover, it is desirable that the compound which has photosensitivity is contained in a photosensitive organic component 10% of the weight or more in respect of the sensibility to light. It is desirable that it is 30 more % of the weight or more. As a compound which has photosensitivity, a photosensitive monomer, photosensitive polymer, or a polymer may be mentioned, in addition additive components, such as a photopolymerization initiator, a sensitizer, a sensitization assistant, polymerization inhibitor, a plasticizer, a thickener, an organic solvent, an antioxidant, a dispersant, and an organic or inorganic suspending agent, may be contained as an organic component during the photosensitive fluorescent substance paste if needed.

[0020] And after usually preparing various components, such as fluorescent substance powder, photosensitive polymer, a photosensitive monomer, a photopolymerization initiator, and a solvent, so that it may become a predetermined presentation, mixed distribution is carried out with 3 rollers or a kneading machine at homogeneity, and a photosensitive fluorescent substance paste is produced.

[0021] Since it heats for 20 to 60 minutes, it dries at 70-90 degrees C and solvents are evaporated after carrying out whole surface spreading on the substrate in which the septum which described above this photosensitive fluorescent substance paste was formed, by the photolithography method, ultraviolet rays are irradiated, and are exposed using masks, such as a film which has a fluorescent substance pattern, or a chromium mask, and photo-curing of the photosensitive fluorescent substance paste is carried out. The mask to be used selects either a negative mold or a positive type according to the class of photosensitive organic component.

[0022] As an aligner, a stepper exposure machine, a pro squeak tee exposure machine, etc. can be used. Moreover, when exposing a large area, after applying a photosensitive fluorescent substance paste on substrates, such as a glass substrate, by exposing conveying, it is the exposure machine of a small exposure area, and big area can be exposed.

[0023] Under the present circumstances, although a visible ray, a near ultraviolet ray, ultraviolet rays, an electron ray, an X-ray, etc. are mentioned, the activity light source used has desirable ultraviolet rays in these, and a low pressure mercury lamp, a high pressure mercury vapor lamp, a halogen lamp, germicidal lamp glass, etc. can be used for it as that light source. An ultrahigh pressure mercury lamp is suitable also in these. Although exposure conditions change with thickness of the spreading film, it is desirable to perform exposure for 10 seconds - 10 minutes using the ultrahigh pressure mercury lamp of the output of 5 - 100 mW/cm2.

[0024] Next, the part which has not been hardened by said exposure using a developer is removed, and a fluorescent substance pattern is formed. Development is performed with dip coating, the shower method, and a spray method. The organic solvent which the mixture of the aforementioned photosensitive organic component can dissolve can be used for the developer to be used. Moreover, water may be added in the range in which the solvent power is not lost by this organic solvent. For example, a carboxyl group can also be developed in an alkali water solution, when a ******** component exists. Although the water solution of alkali metal, such as a sodium hydroxide, a sodium carbonate, a sodium-hydrogencarbonate water solution, and a barium hydroxide, can be used as an alkali water solution, since having used the organic alkali water solution tends to remove an alkali component at the time of baking, it is desirable.

[0025] As an example of organic alkali, tetramethylammonium hydroxide, trimethyl benzyl ammonium hydroxide,

monoethanolamine, diethanolamine, etc. are mentioned. The concentration of an alkali water solution is usually 0.1 - 0.5 % of the weight more preferably 0.05 to 2% of the weight. Without removing an unexposed part, if alkali concentration is too low, if alkali concentration is too high, there is a possibility of making the exposure section corroding.

[0026] Next, the spreading film after exposure and development is calcinated in air. Completely, it oxidizes and the organic substance of addition components, such as reactant components, such as photosensitive polymer which is a photosensitive organic component, and a photosensitive monomer, and a binder, a photopolymerization initiator, a sensitizer, a sensitization assistant, a plasticizer, a thickener, an organic solvent, and a dispersant, is evaporated. It is desirable to calcinate at 300-550 degrees C as baking conditions for 15 minutes to 1 hour, to decompose and to make an organic binder component burned down. At less than 300 degrees C, since baking is inadequate, a binder component remains and it leads to the fall of luminescence brightness. Moreover, when 550 degrees C is exceeded, there is an inclination for fluorescent substance powder to deteriorate and for brightness to fall.

[0027] By repeating such a process 3 times, a fluorescent substance layer forms red, blue, and green, and enables the full color display. And it is desirable to form a fluorescent substance layer with a thickness of 5-35 micrometers on 5-35 micrometers and a septum side face in the pars basilaris ossis occipitalis in the discharge space divided between the side face of a septum and the septum after baking at the point of forming PDP of high brightness luminescence. If the fluorescent substance powder described above as thickness is less than 5 micrometers, respectively is used, fluorescent substance powder may be unable to obtain sufficient brightness without powder's existing in a fluorescent substance layer only in one particle. Moreover, if 35 micrometers is exceeded, the discharge space formed between septa will become less enough, and will lead to the fall of brightness.

[0028] Thus, the produced tooth-back plate is combined with a front plate, and PDP of this invention is manufactured by enclosing gas.

[0029]

[Example] Hereafter, the example of this invention is explained. However, this invention is not limited to this.

[0030] The red photosensitivity fluorescent substance paste was produced using BO (Y, Gd, Eu)3 as example 1 fluorescent-substance powder. The looseness umbrella consistency and tap density of the used powder are shown in Table 1. Moreover, powdered particle size distribution are shown in Table 2. The photosensitive fluorescent substance paste was manufactured in the following procedure using this inorganic fluorescent substance powder. First, it dissolves, heating each component of an organic component at 80 degrees C. And a monomer (TPA330) is mixed for a polymer and gamma-butyrolactone is mixed for a photopolymerization initiator (IC907) 28.8% of the weight as a solvent 0.2% of the weight 10.7% of the weight 17.8% of the weight. And finally red color fluorescent substance powder was added 42.5% of the weight, and it kneaded with 3 rollers. The amount of solvents adjusted viscosity.

[0031] Next, the above-mentioned fluorescent substance paste was applied by complete screen-stencil by pitch 130micrometer on the glass substrate with which the septum with the line breadth of 50 micrometers, a line breadth [an electrode with a thickness of 7 micrometers and line breadth of 30 micrometers], and a thickness of 120 micrometers is formed. Then, it dried for 40 minutes at 80 degrees C. After desiccation, it cooled to the room temperature, the photo mask was carried, it exposed by 100 mJ/cm2, and shower development was further carried out in the alkali water solution. It put in into oven for 20 minutes at 80 degrees C so that moisture might fully dry after that. The pattern of the shape of a red stripe was able to be formed.

[0032] The glass substrate by which pattern processing of the red fluorescent substance paste was carried out in the above-mentioned procedure was calcinated for 30 minutes at 500 degrees C.

[0033] When the configuration of the formed fluorescent substance layer was observed using the laser beam microscope, it was able to obtain the 15-25-micrometer uniform fluorescent substance layer of target thickness at the side face of a septum, and the pars basilaris ossis occipitalis between septa.

[0034] The luminescence brightness of the manufactured tooth-back substrate for PDP was measured. 254nm light was irradiated in the distance of 50cm using EF-140C/J made from Spectronics Corporation as the excitation light source of a fluorescent substance. Luminance-meter LS-100 made from Minolta were used for an exposure and coincidence, and brightness was measured every 5 seconds. The value of brightness used the value 5 minutes after after an exposure. The result was shown in Table 3.

[0035] The blue fluorescent substance paste was produced using fluorescent substance powder different example 2, and the tooth-back substrate for PDP was manufactured like the example 1 except having formed the fluorescent substance layer. BaMgAl10O17:Eu was used as fluorescent substance powder. A consistency, particle-size-distribution measurement, and a brightness result were shown in Tables 1, 2, and 3. The configuration of the formed fluorescent substance layer was observed using the laser beam microscope. Consequently, the 15-25-micrometer uniform

fluorescent substance layer of target thickness was able to be obtained.

[0036] The green fluorescent substance paste was produced using fluorescent substance powder different example 3, and the tooth-back substrate for PDP was produced like the example 1 except having formed the fluorescent substance layer. Zn2SiO4:Mn was used as fluorescent substance powder. A consistency, particle-size-distribution measurement, and a brightness result were shown in Tables 1, 2, and 3. The configuration of the formed fluorescent substance layer was observed using the laser beam microscope. Consequently, the 15-25-micrometer uniform fluorescent substance layer of target thickness was able to be obtained.

[0037] On the glass substrate with which the septum with a line breadth [of 50 micrometers], an electrode with a thickness of 7 micrometers, a dielectric, a line breadth [of 30 micrometers], and a thickness of 120 micrometers is formed, using the fluorescent substance paste of each color obtained in the examples 1-3, spreading of a paste, exposure, development, and baking were repeated for every color, and red, blue, and a green fluorescent substance layer were formed by example 4 pitch 130micrometer.

[0038] The obtained substrate was used as the tooth-back substrate for PDP, and it combined with the front plate, and when PDP was manufactured by enclosing gas, it excelled in the quality display.

[0039] The blue fluorescent substance paste was produced like the example 3 except having used the fluorescent substance powder with which the example consistency of a comparison differs from grain size. A consistency, particle-size-distribution measurement, and a brightness result were shown in Tables 1, 2, and 3. The configuration of the formed fluorescent substance layer was observed using the laser beam microscope. Consequently, between the septum and the fluorescent substance layer, the crack arose and a good fluorescent substance layer was not able to be obtained.

[0040] In addition, the polymer, monomer (TPA330), and IC907 which were used in an above-mentioned example and the above-mentioned example of a comparison are as follows.

polymer: -- polymer monomer (TPA330):trimethylolpropane triacrylate MODIFAIDO POIC which carried out the addition reaction of the 0.4Eq glycidyl methacrylate to the side chain to the copolymer carboxyl group which consists of the methacrylic acid of 40% of acrylic copolymers which have a carboxyl group and an ethylene partial saturation radical, 30% of methyl methacrylate, and styrene of 30% ** -- 907:2-methyl-1-[4-(methylthio) phenyl]-2-morpholino propanone [Table 1]

表1．密度測定結果

	実施例1	実施例2	実施例3	比較例
タップ密度[g/cm³]	0．62	0．77	0．59	0．35
ゆるみカサ密度[g/cm³]	1．57	1．65	1．40	1．65
ﾀｯﾌﾟ/ゆるみカサ	0．39	0．47	0．42	0．21

[Table 2]

表2．粒度分布測定結果

	実施例1	実施例2	実施例3	比較例
累積平均粒子径[μm]	2．7	3．7	3．6	5．4
比表面積[m²/cc]	3．1	2．3	2．5	1．7
標準偏差	1．5	2．0	2．3	2．8

[Table 3]

表3．輝度結果

	実施例1	実施例2	実施例3	比較例
輝度[cd/cm²]	0．28	0．60	0．50	0．43

[0041]

[Effect of the Invention] Since the plasma display of this invention is a thing containing the fluorescent substance layer which loosened with tap density and was formed using the fluorescent substance powder the range of whose ratio of an umbrella consistency is 0.3-0.6, the fluorescent substance stratification of it becomes [the side face and pars basilaris ossis occipitalis of a septum] possible at homogeneity. this -- high -- a brightness plasma display is producible.

[Translation done.]